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American Iron and Steel Institute Tests on cold formed steel studs

American Iron and Steel Institute

AMERICAN IRON AND STEEL INSTITUTE
TESTS ON COLD FORMED STEEL STUDS

THIRD PROGRESS REPORT
May 28, 1940

I. SCOPE

This report presents results of buckling tests on:
Type A studs with free-ends condition.
Type B studs with "minimum restraint" or "actual" end condition.

II. GRAPHICAL REPRESENTATION

The buckling curves for the above tests are shown in Figs. 9 to) inclusive.

III. METHOD OF TESTING

The general procedure of testing was the same as described in the econd progress report.

The type A, free-end tests were made in exactly the manner described n the progress report No. 2 except that the deflection wire was fastened ithin one-half inch of the knife edge.

Type B studs, "actual" end condition were tested with ends bearing irectly on a flat steel test plate, the end of the stud being held in lace and to the plate by means of a single bolt through a clip angle. his test condition is illustrated by the attached photograph.

IV. RESULTS

Figs. 9 to 13 inclusive show load-deflection diagrams for the Type studs with free-ends. Figs. 14 to 18 inclusive show the load deflection relation for the Type B studs with "actual" ends. After each load pplication the load was reduced to its initial value and the permanent et as observed is indicated by the solid circles.

) Type A studs. For each stud the critical load was computed from uler's formula using $E = 29.5 \times 10^6$, the distance between the knife dges of the test base being taken as the effective length, and the verage thickness of material of the particular specimen was used for etermining I. The specimens so far measured were found to have a maximum variation in I, due to their differing thicknesses, of 5 percent.

TABLE I.

Comparison of theoretical and actual ultimate loads for Type A studs

Length	l/r Nominal	With test base	Mean ultimate load (lbs.)	Euler Critical load	Percent Difference
4'	142	151	8633	8890	-2.9
6'	212	222	4023	4163	-3.4
8'	284	294	2190	2250	-2.7
10'	355	364	1452	1483	-2.1
12'	426	436	1098	1083	+1.4

b) Type B studs. Considerable variation in load deflection relations between the various specimens was observed. The bearing of the end of the stud on the steel plate was not always complete. In some cases only the web was in contact and in others the ends of the flanges and only a portion of the web bore on the plate. When the initial bearing was at the end of the flange edge local failure at those points caused the bearing to be transferred to points closer to the neutral plane and consequently changed the load-deflection relationship. The curves of Fig. 14 illustrate such characteristics due to variation in bearing.

Stud 4B16A1 had bearing along the end of the web only. Thus as load was applied the stud deflected with concavity relative to the back of the channel. The end of the flanges did not bear until considerable load and deflection was on the stud and therefore the contact of the flanges did not cause a reversal of the deflection, and the stud continued to bend with back of channel concave to the longitudinal axis. The resultant tension in the flanges was the cause of failure.

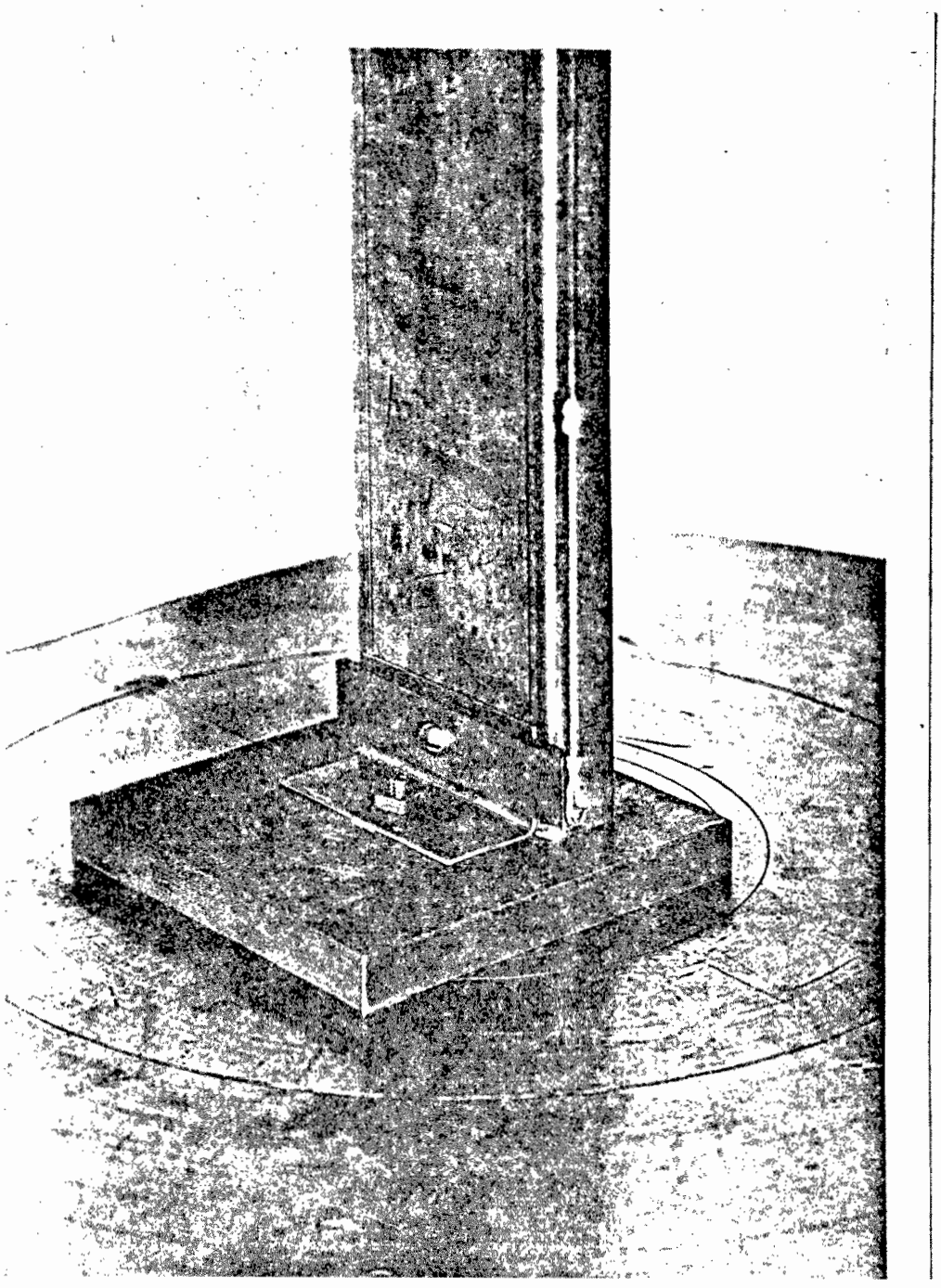
Deflections increased rapidly or slowly and to the right or to the left depending upon bearing conditions at the ends of the studs. The dashed line from the ultimate load point on the graphs is drawn to indicate the observed behaviour of the studs. When the ultimate load was reached there was an instantaneous increase in deflection amounting to several times its value near the ultimate load. This "flip" of the stud was so rapid that accurate deflection readings could not be made, and so were omitted.

TABLE II

Buckling Tests on Type B Studs with Minimum Restraint

Length	Ultimate Load	Obs. Ult. load for free-end	Ratio of av. of ult. loads "actual" end to "free" end
4'	6250		
	6600		
	3900		
Av.	5583	2812	2.0

ength	Ultimate Load	Obs. Ult. Load for free-end	Ratio of av.of ult.loads "actual" end to "free" end
6'	3770		
	4800		
	4700		
	Av. 4423	1332	3.3
8'	1700		
	2920		
	1250		
	Av. 1957	795	2.5
10'	760		
	1660		
	1610	468	
	1343		2.9
12'	1130		
	1020		
	730		
	Av. 967	313	3.1



LOAD - DEFLECTION CURVES

LENGTH 4 FT., TYPE A

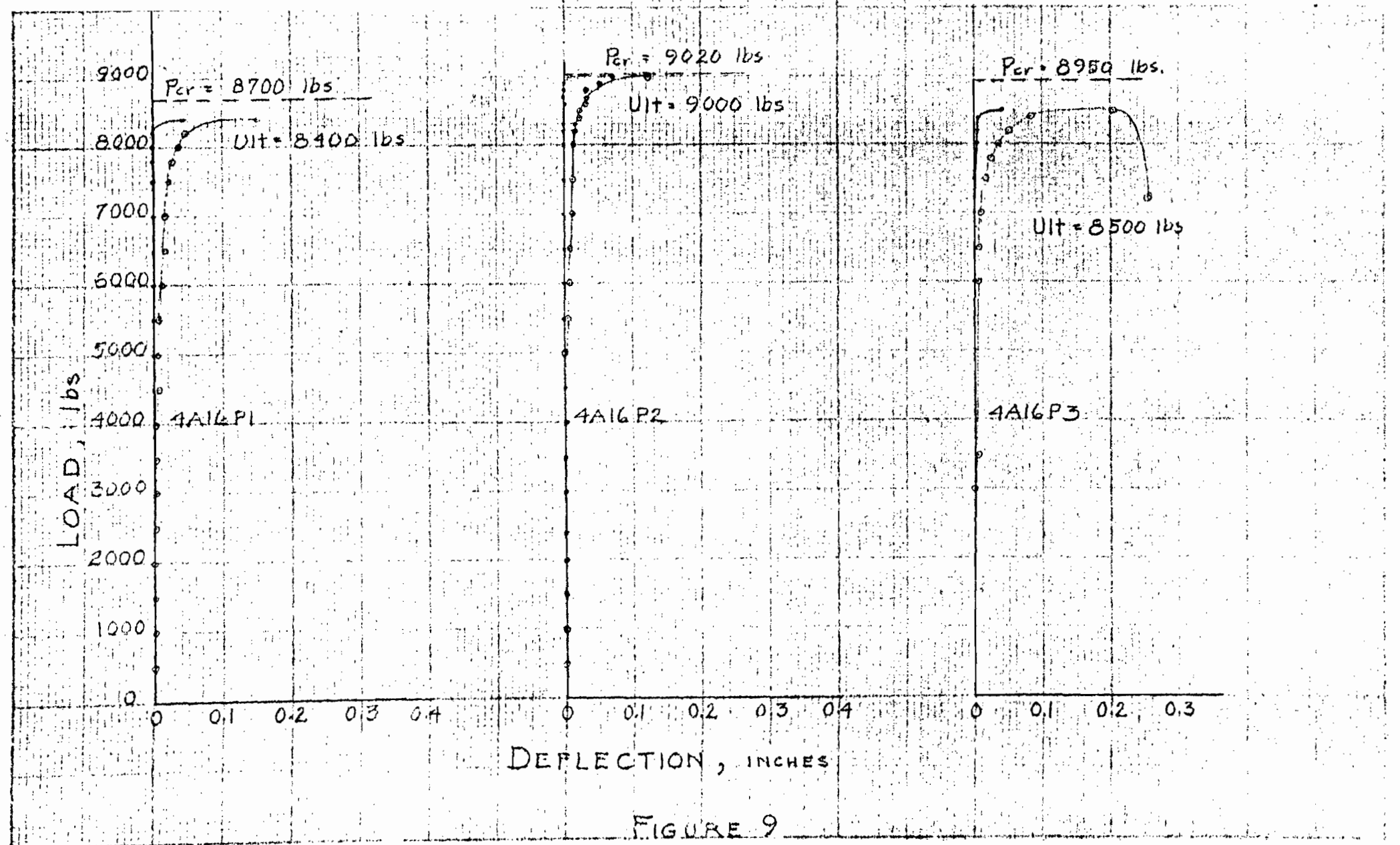


FIGURE 9

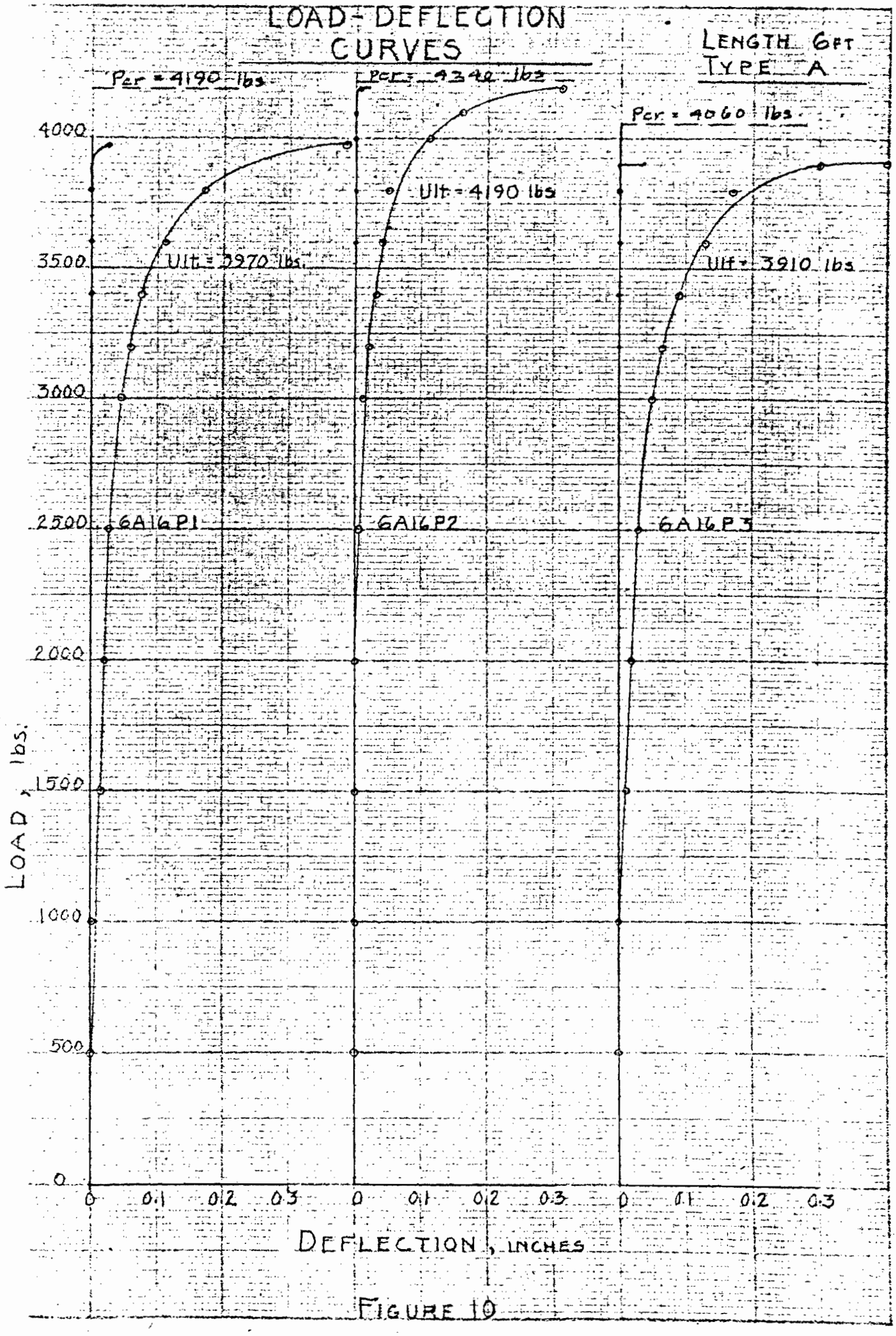

LOAD-DEFLECTION CURVES
LENGTH 6FT
TYPE A
Per = 4190 lbs
Per = 4340 lbs
Per = 4060 lbs
Ult = 3970 lbs.
Ult = 4190 lbs
Ult = 3910 lbs
6A16P1
6A16P2
6A16P3
4000
3500
3000
2500
2000
1500
1000
500
0
LOAD, lbs.
0
0.1
0.2
0.3
DEFLECTION, INCHES

FIGURE 10

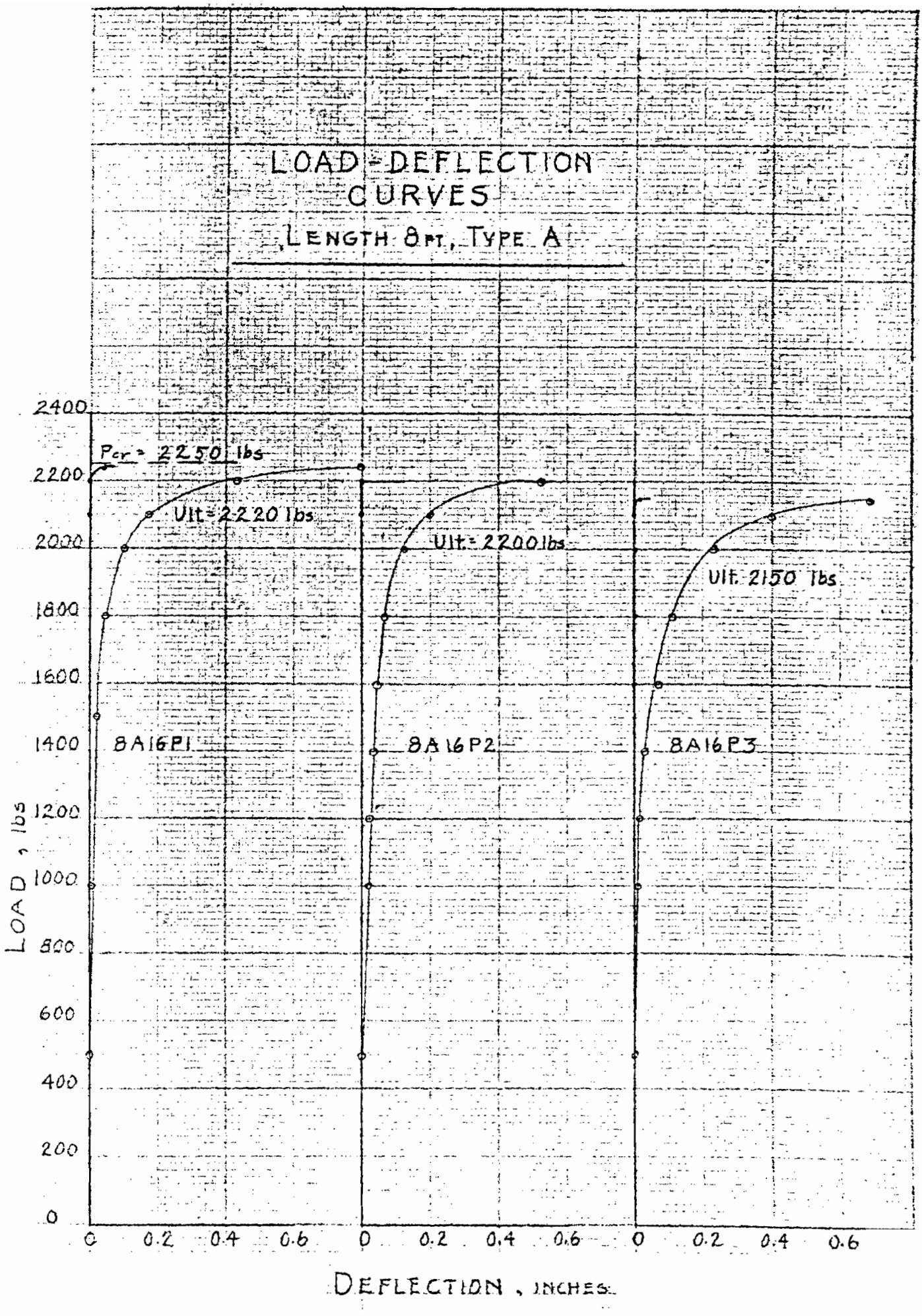

LOAD-DEFLECTION CURVES
LENGTH 8 FT., TYPE A
Pcr = 2250 lbs
Ult = 2220 lbs
Ult = 2200 lbs
Ult. 2150 lbs
8A16P1
8A16P2
8A16P3
LOAD, lbs
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
DEFLECTION, INCHES.

FIGURE 11

LOAD - DEFLECTION CURVES

LENGTH 10 FT., TYPE A

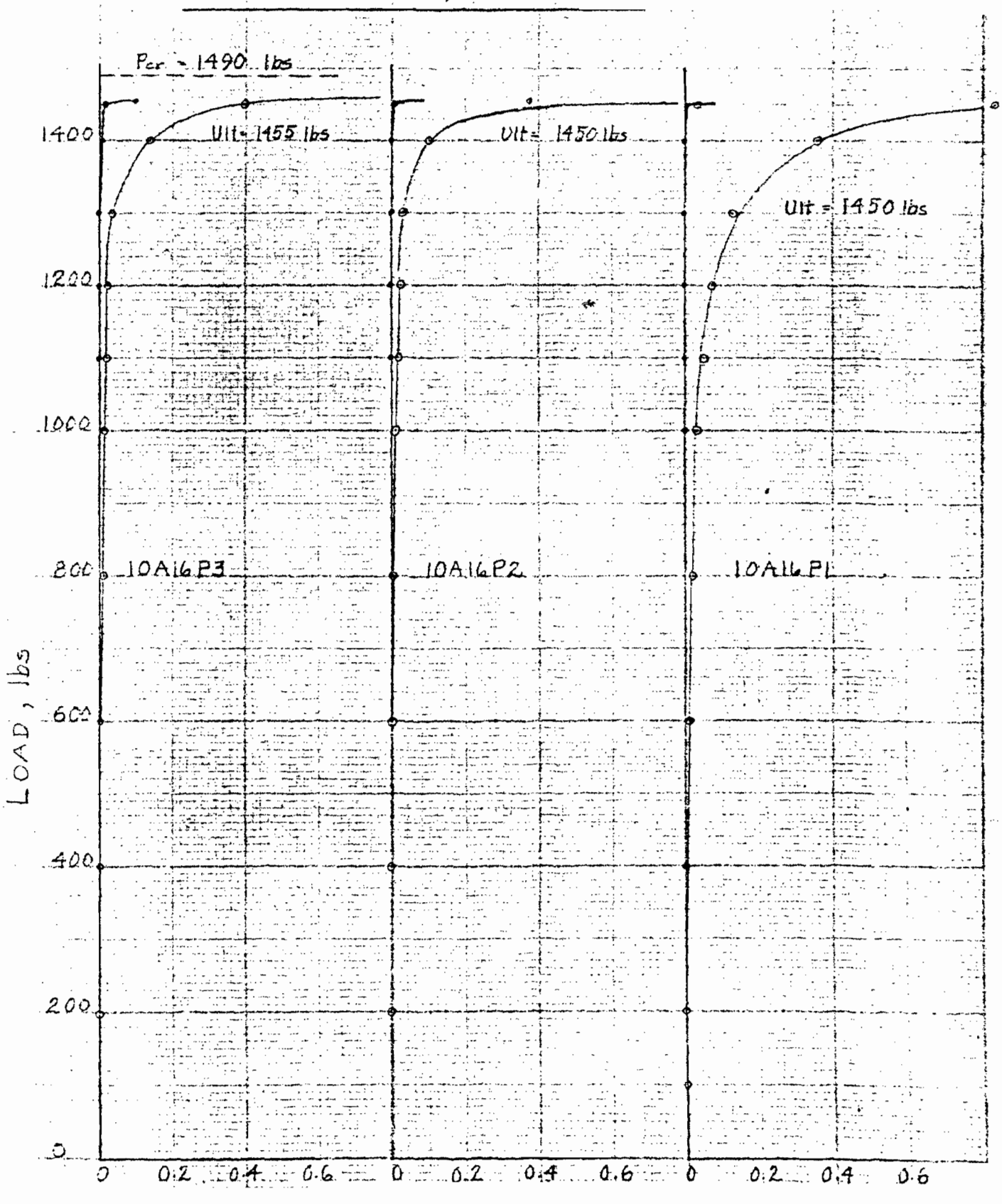


FIGURE 12

LOAD-DEFLECTION CURVES

LENGTH 12 FT. TYPE A

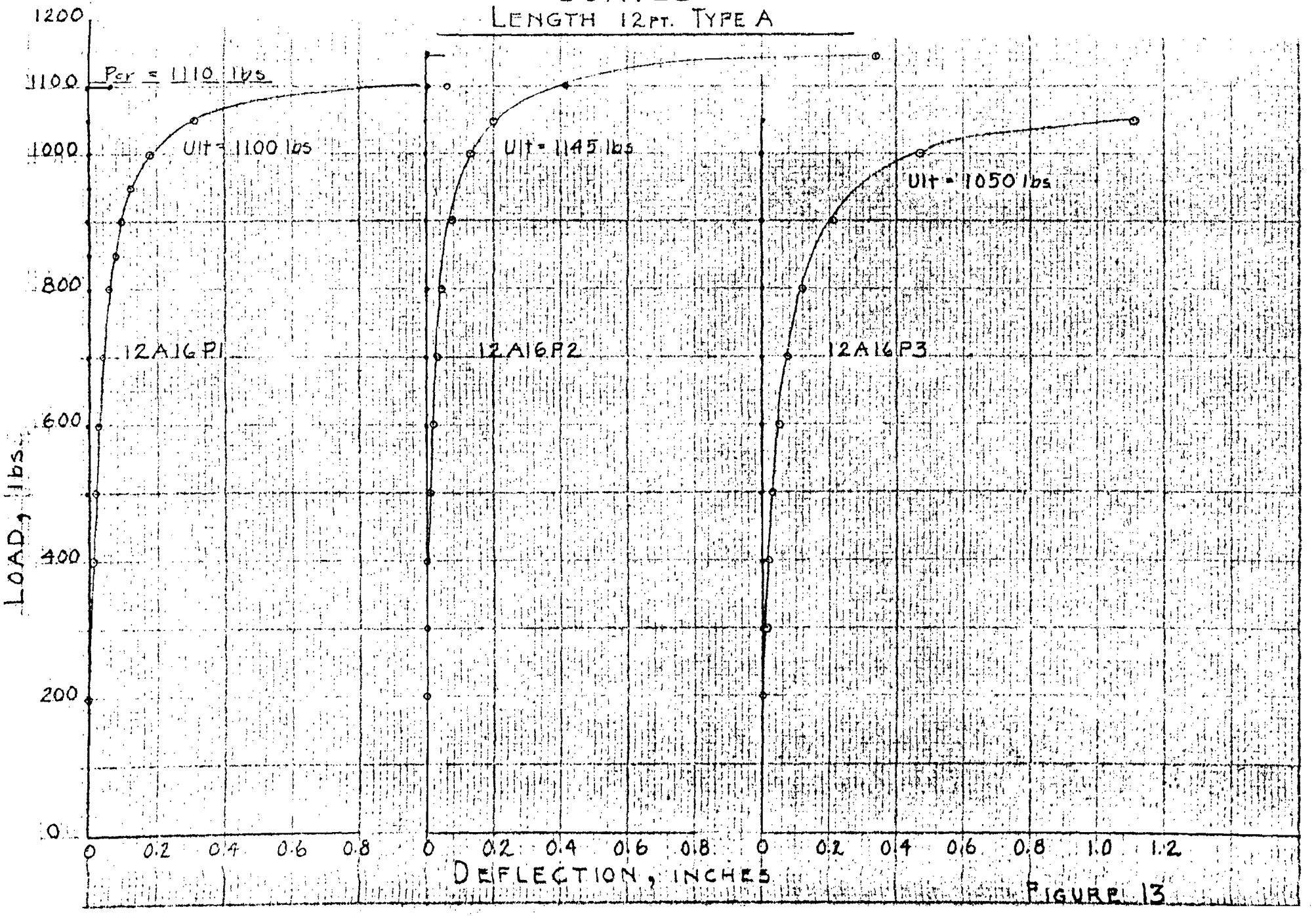


FIGURE 13

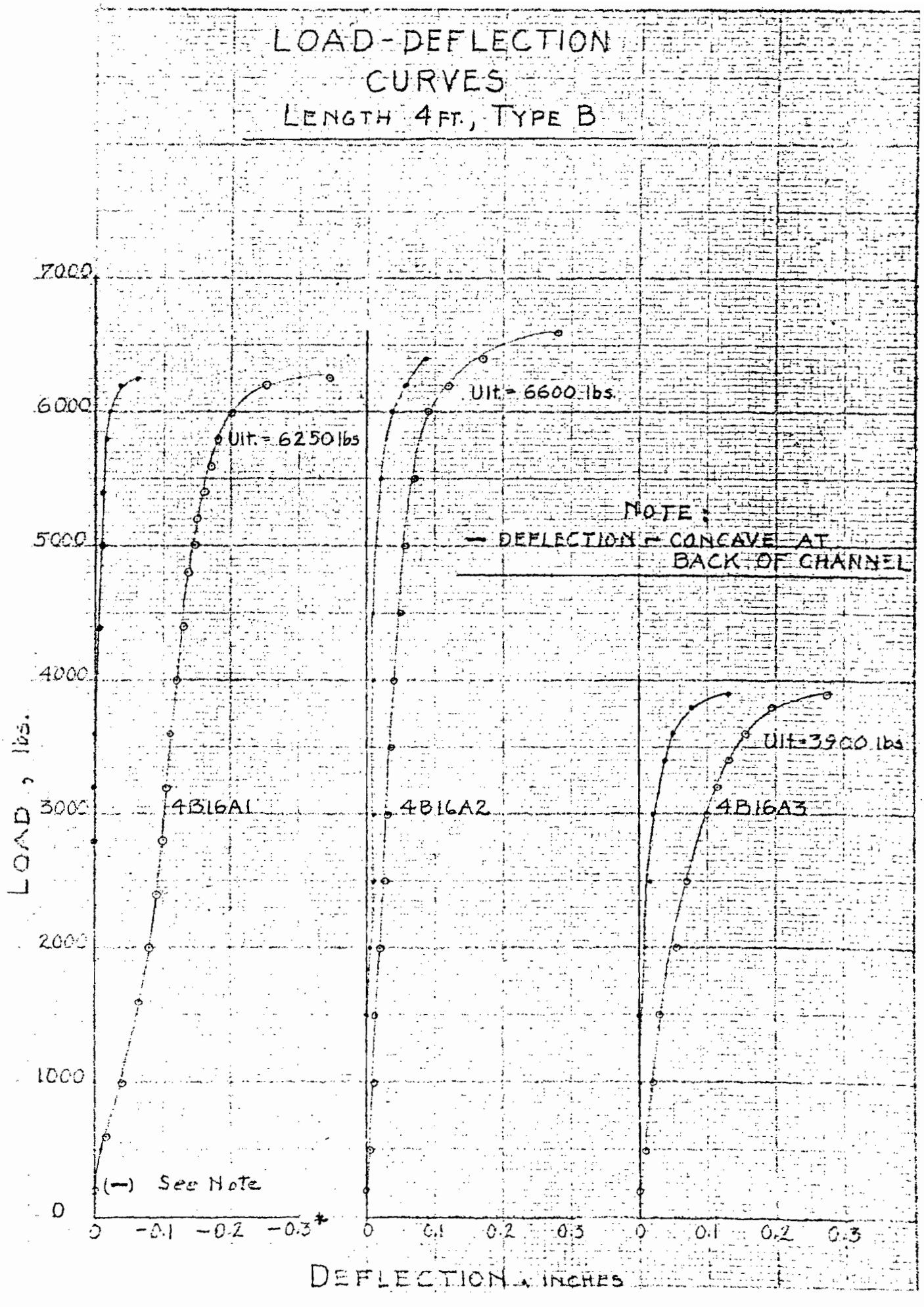

LOAD-DEFLECTION CURVES
LENGTH 4 FT., TYPE B
7000
6000
5000
4000
3000
2000
1000
0
LOAD, lbs.
Ult. = 6250 lbs
Ult. = 6600 lbs.
Ult. = 3900 lbs
NOTE:
— DEFLECTION = CONCAVE AT BACK OF CHANNEL
4B16A1
4B16A2
4B16A3
(—) See Note
0 -0.1 -0.2 -0.3*
0 0.1 0.2 0.3
0 0.1 0.2 0.3
DEFLECTION, INCHES

FIGURE 14

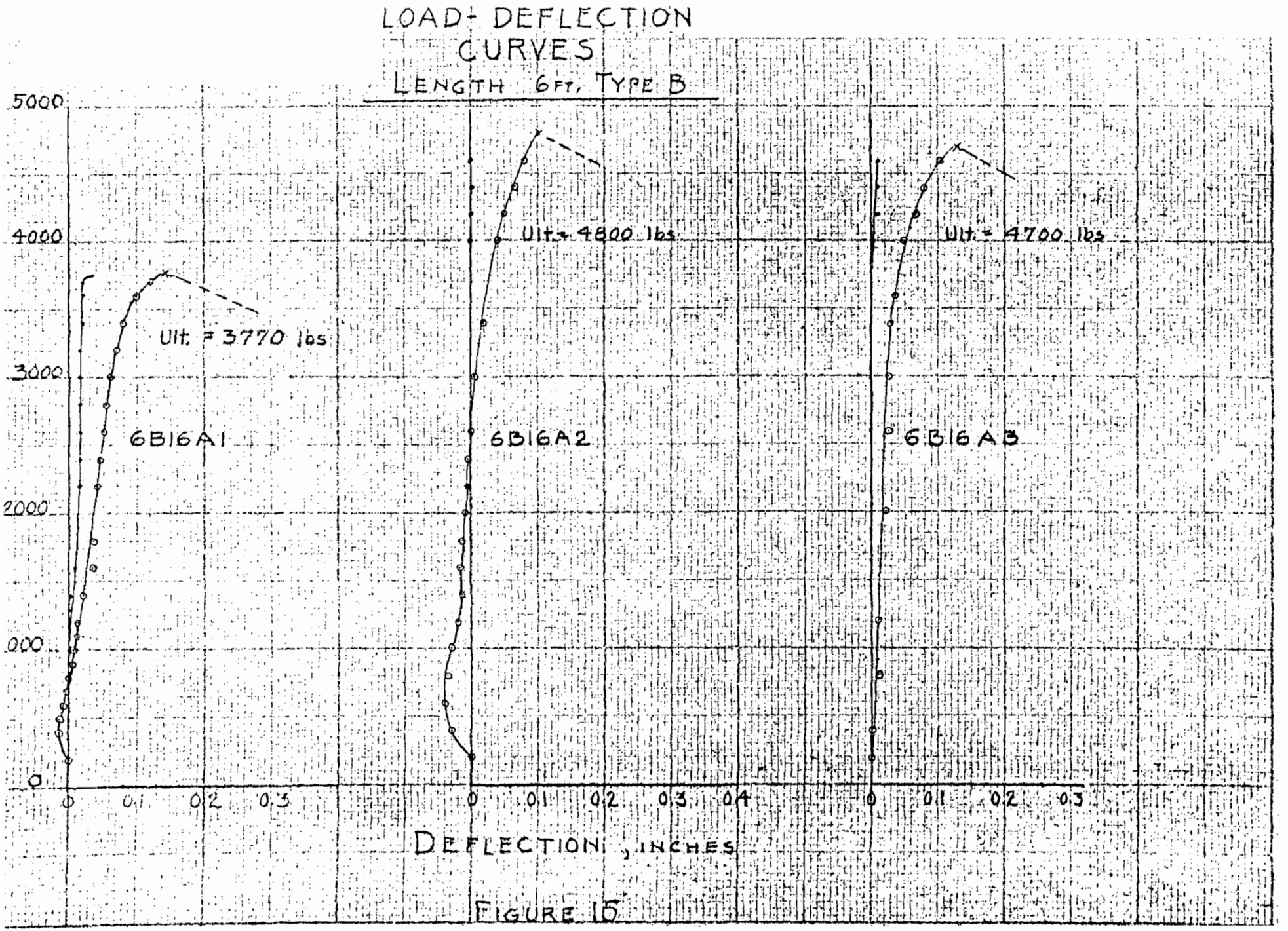

LOAD- DEFLECTION CURVES
LENGTH 6FT, TYPE B
5000
4000
3000
2000
000
0
Ult. = 3770 lbs
6B16A1
Ult. = 4800 lbs
6B16A2
Ult. = 4700 lbs
6B16A3
0
0.1
0.2
0.3
0
0.1
0.2
0.3
0.4
0
0.1
0.2
0.3
DEFLECTION, INCHES

FIGURE 15

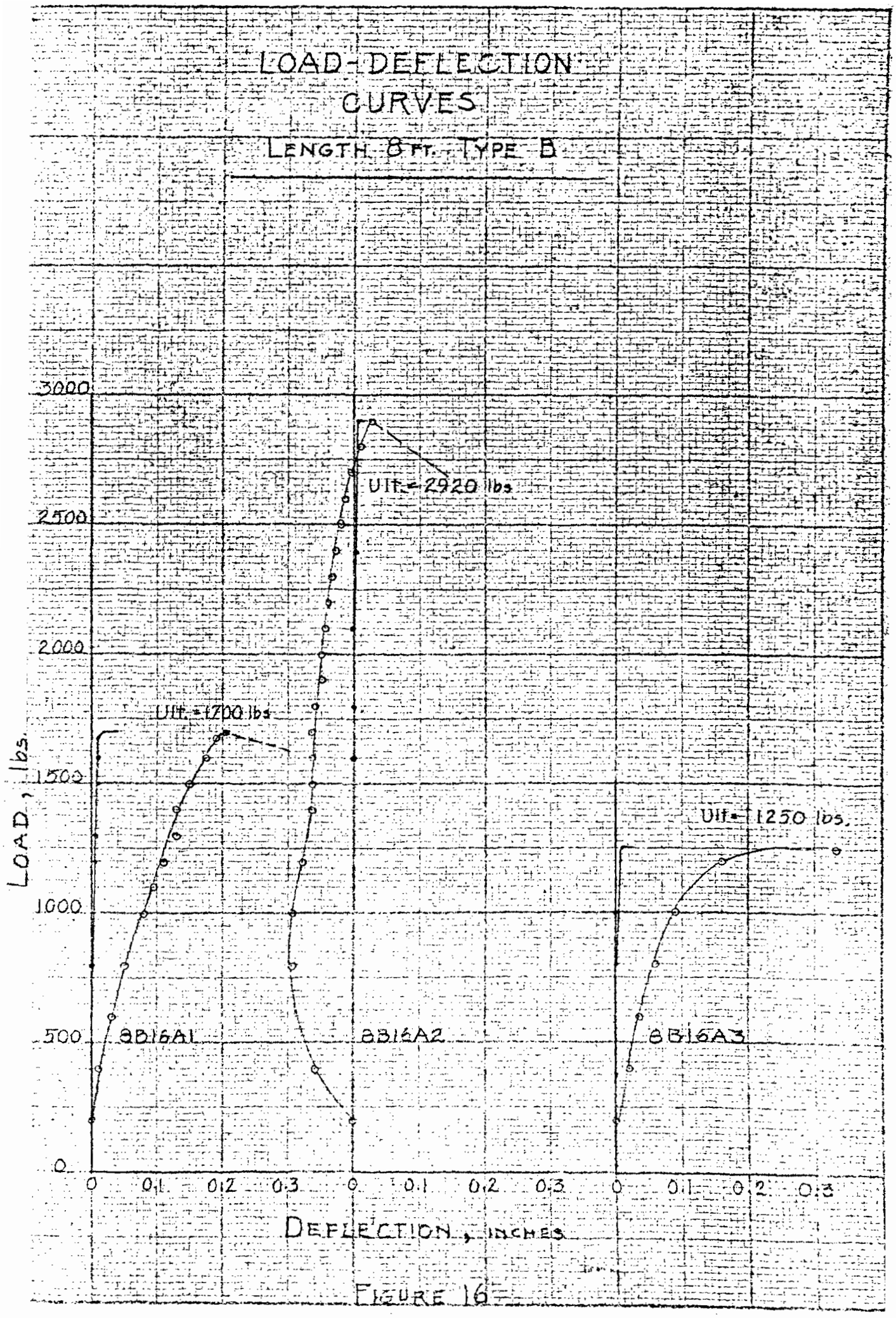

LOAD-DEFLECTION CURVES
LENGTH 8 FT. TYPE B
3000
2500
2000
1500
1000
500
0
LOAD, lbs.
Ult.=2920 lbs
Ult.=1700 lbs
Ult.=1250 lbs.
8B16A1
8B16A2
8B16A3
0
0.1
0.2
0.3
DEFLECTION, INCHES

FIGURE 16

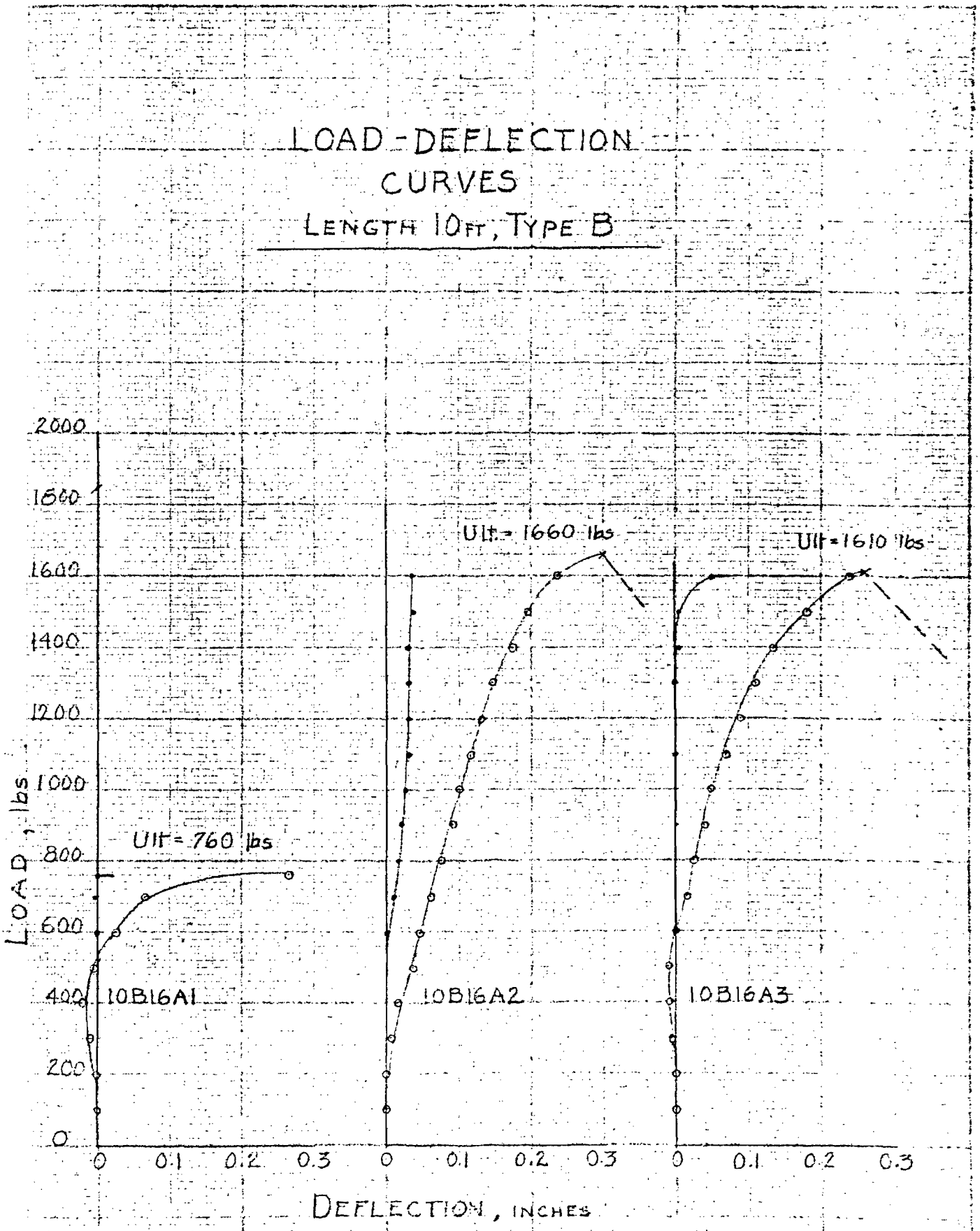

LOAD - DEFLECTION
CURVES
LENGTH 10 FT, TYPE B
LOAD, lbs
2000
1800
1600
1400
1200
1000
800
600
400
200
0
ULT = 760 lbs
10B16A1
ULT = 1660 lbs
10B16A2
ULT = 1610 lbs
10B16A3
0
0.1
0.2
0.3
DEFLECTION, INCHES

FIGURE 17

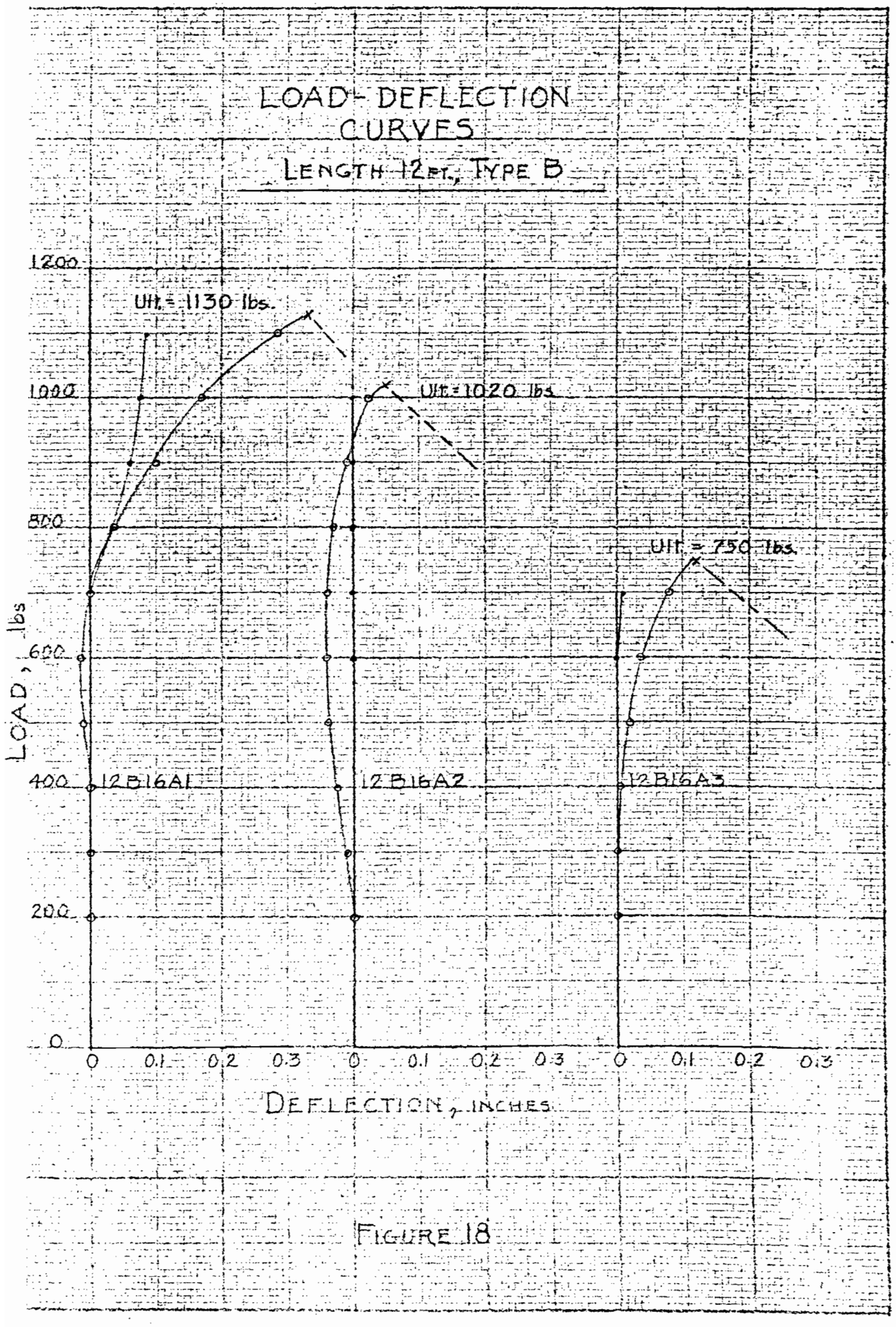

LOAD - DEFLECTION CURVES
LENGTH 12 FT., TYPE B
1200
1000
800
600
400
200
0
LOAD, lbs
Ult. = 1130 lbs.
Ult. = 1020 lbs.
Ult. = 750 lbs.
12B16A1
12B16A2
12B16A3
0
0.1
0.2
0.3
DEFLECTION, INCHES

FIGURE 18